



November 9, 2011

FILED ELECTRONICALLY

Marlene H. Dortch, Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, DC 20554

**Re: *Ex Parte* Presentation of the U.S. GPS Industry Council in
File No. SAT-MOD-20101118-00239 and IB Docket No. 11-109**

Dear Ms. Dortch:

In this letter, the U.S. GPS Industry Council (“USGIC”) responds to claims made by and on behalf of LightSquared Subsidiary LLC (“LightSquared”) in an October 6, 2011 *ex parte* notification in the above-referenced proceedings. *See* Letter from H. Goldberg, Counsel for LightSquared, to M. Dortch, Secretary, FCC, in File No. SAT-MOD-20101118-00239 and IB Docket No. 11-109 (filed October 6, 2011) (“LightSquared Letter”). Nothing in the LightSquared Letter alters the fact that LightSquared has failed to demonstrate in a verifiable way the ability to mitigate the harmful interference its operation of a nationwide stand-alone 4G LTE terrestrial mobile broadband service in the lower 10 MHz of the 1525-1559 MHz band would cause to systems and networks in the radionavigation-satellite service (“RNSS”) – including the Global Positioning System (“GPS”) – that operate in the 1559-1610 MHz RNSS band. The USGIC addresses each of the points from the LightSquared Letter in turn below.

The USGIC notes at the outset that all of the discussion in the LightSquared Letter is exclusively in the context of attempting to enable LightSquared to conduct terrestrial mobile broadband operations in the lower 10 MHz segment of the 1525-1559 MHz band (i.e., the 1526-1536 MHz band). Serious interference problems persist with the lower 10 MHz segment, as detailed below. These problems are separate from, but compounded by, the fundamentally intractable difficulties that are presented by LightSquared’s persistence in pursuing the possibility of future operation on the upper 10 MHz segment of the 1525-1559 MHz band (specifically, at 1545-1555 MHz). The USGIC maintains that the established technical impossibility of compatible 4G LTE operations on the upper 10 MHz of the 1525-1559 MHz band with GPS and other RNSS operations in the 1559-1610 MHz band requires that the possibility of 4G LTE terrestrial mobile operations in the upper 10 MHz segment be permanently removed from consideration by the Commission, and that no portion of the band other than the 1526-1536 MHz lower 10 MHz segment shall be examined. With the upper 10 MHz segment, the impact to GPS receivers would be profound across all receiver types and applications, and there are no known or proposed filters or other mitigation techniques that can protect GPS receivers from harmful interference.

Moreover, since the vendor announcements featured in the LightSquared Letter would only mitigate interference prospectively, existing GPS devices would have to be immediately replaced or retrofitted in order to accommodate LightSquared operations in the lower band. As is clear from the record before the Commission, many GPS devices have useful lives of 10 to 15 years, and certification processes for critical GPS receiver functions such as aviation and military use can take many years. LightSquared's continued insistence on eventual operations in the upper 10 MHz band at some unspecified point in the future creates uncertainties for all of these functions and cannot be allowed to remain as a permissible option. The upper 10 MHz segment must be permanently removed from consideration.

GPS has been and will continue to be a tremendous source of innovation and benefit to our nation's economy due in large part to balanced and far-sighted government policy. The Commission must not burden the industry and the huge base of GPS users, including critical industry and government applications, with further uncertainty by leaving open the possibility of future operations in the upper band.

With respect to the material in the LightSquared Letter, the USGIC emphasizes first that LightSquared's assertions regarding the compatibility of a "process of reconfiguring the filters and linear amplifiers of [some existing GPS] receivers" (*see* LightSquared Letter at 2 and Attachment B) are premature, and are insufficient to enable a Commission determination that LightSquared's proposed 4G LTE service is compatible with GPS operations in the 1559-1610 MHz band. Next, and in response to LightSquared's presentation of material pertaining to a new ceramic filter (*see* LightSquared Letter at Attachment C), the USGIC emphasizes that no filtering solution or solutions can be deemed to mitigate the harmful interference that LightSquared would cause to GPS on the lower 10 MHz segment unless and until (i) it is proven in testing to mitigate interference without a performance penalty on GPS, and (ii) it is demonstrated that feasible filtering solutions exist to retrofit all currently-deployed GPS receivers that would suffer harmful interference. Finally, the USGIC demonstrates that LightSquared's presentation regarding the possibility of limiting LightSquared power on the ground around its 4G LTE terrestrial base station transmitters (*see* LightSquared Letter at Attachment D) suffers from several fundamental flaws.

The Javad "Process"

LightSquared first presents material purporting to show that a company called Javad Inc. ("Javad") has designed a "process" of reconfiguring existing Javad high-precision GPS receivers so that they can work compatibly with LightSquared 4G LTE terrestrial mobile service transmissions in the lower 10 MHz (1526-1536 MHz) of the 1525-1559 MHz mobile-satellite service ("MSS") band. Even a cursory examination of the proffered material shows that the "solution" LightSquared claims is not yet at hand. The USGIC offers the following points in response:

1. The presentation is extremely thin on details. Apparently, reconfiguration of filters and low noise amplifiers of fielded receivers is envisioned, but no specifics were

- offered. At this point, the Javad “process” is no more reliable or credible than the unfounded assertions LightSquared made throughout the Commission-ordered Technical Working Group (“TWG”) testing earlier this year regarding future possible filtering approaches. Since the vendor has an obvious economic incentive to present its technology as a solution, such claims must be met with a healthy degree of skepticism.
2. For Javad precision receivers, the cost to change antennas and possibly low noise amplifiers to become “LightSquared compatible” is purportedly in a range of \$300 to \$800 depending on the Javad model involved. Critically, LightSquared made no pledge to assume the costs (which presumably are for only the parts and do not include installation or lost productivity time during retrofitting and post-retrofitting calibrations) even for Javad receivers. The USGIC also notes that the high end of the cost range doubled from \$400 to \$800 between October 4, 2011 (the date of the article sourced in the email message included as Attachment E to the LightSquared Letter) and the October 5, 2011 joint LightSquared/Javad presentation to Commission staff. This fluctuation suggests that the cost elements even for Javad products have not yet stabilized.
 3. For high-precision, network, and timing receivers from other manufacturers, and for all other types of GPS receivers that were shown in the Technical Working Group report to be susceptible to harmful interference from LightSquared’s proposed lower 10 MHz 4G LTE terrestrial mobile service, LightSquared offers only the blanket, unsupported assertion that “the same solution could apply.” LightSquared Letter at 2. Needless to say, there are many different types of GPS receivers from many different manufacturers, and no single solution will apply to all of the receivers and devices that would be impacted by LightSquared’s proposed 4G LTE operation. The USGIC wishes to make its position on this point emphatically clear: any technical solution or solutions must be tested and validated for each receiver type, and all costs (equipment, installation, and lost productivity) must be borne by LightSquared. The Commission must require LightSquared unconditionally to assume these costs and must not permit LightSquared to commence service until all GPS receivers are confirmed to be protected from harmful interference.
 4. LightSquared and Javad are incorrect in their assertion that “all existing receivers that cannot track new GPS signals (L1C, L2C, L5) will be obsolete in about five years.” See LightSquared Letter at 2.
 - a. The first GPS III satellite with the wideband L1C signal is not due to be launched until 2014, and a 24-satellite constellation with this signal will not be available until 2026. (See GPS Program Update to CGSIC 2011 from Col. B. Gruber, Director, Global Positioning System Directorate, at 9 (September 20, 2011).) With respect to the timetable for the other wideband signals, timing is such that receivers utilizing the current GPS P(Y) signal will continue to be required for at least the next decade. In a September 2008

public notice, the Department of Defense committed to supporting codeless/semi-codeless access to the GPS P(Y) signals until December 31, 2020, which represents the planned availability of the second and third coded civil GPS signals being broadcast from a minimum of 24 GPS satellites. (*See* Office of the Secretary, Department of Defense, “Preservation of Continuity for Semi-Codeless GPS Applications,” 73 Fed. Reg. 54792 (Sept. 23, 2008).) The Department of Defense will reassess the transition date should significant GPS program delays arise. Receivers that do not track the forthcoming GPS wideband signals will clearly continue to be relevant well beyond the “about five years” timeframe posited by LightSquared.

- b. Current high-precision, network, and timing receivers are already capable of receiving and utilizing the forthcoming GPS wideband signals as well as those from other RNSS systems. There is no reason to expect that any of these current receivers would need to be replaced prior to the end of their normal operating lives – which, as the Technical Working Group report and comments in IB Docket No. 11-109 confirm, could extend a decade or more from the date of purchase.
 - c. All the signals in use today will continue to be available throughout the lifetime of current receivers – there is no plan to exclude or obsolete existing signals from new satellites. Absent interference from LightSquared’s terrestrial signals, GPS users will continue to enjoy the same level of performance throughout the normal lifetime of their equipment.
5. There is no way to verify or even quantify LightSquared’s claims that the Javad process “will provide outstanding performance.” Neither LightSquared nor Javad present any data to support this claim. As the USGIC has repeatedly emphasized, the filtering ideas offered as mitigation techniques by LightSquared to date have suffered from two fundamental defects: The first – unavailability of hardware for testing and confirmation – remains the case here as noted above. The second defect – that increased filtering may impose a performance penalty on GPS receiver accuracy that is unacceptable for the users and applications that rely on extremely accurate measurement data – has never even been acknowledged by LightSquared. As the USGIC, several of its members, and multiple commenters have reminded the Commission, radionavigation signals are different in kind from radiocommunication signals. The LightSquared Letter fails to provide any indication that the potential Javad solution for Javad receivers will not bring an unacceptable performance penalty for its or other high-precision, network, and timing receivers. The qualitative claim of “outstanding performance” is simply insufficient.

The USGIC has no desire to block progress or impede any rational efforts to advance the national broadband agenda. The USGIC’s only motivation is assuring that the operations by authorized RNSS systems and networks that take place in the 1559-1610 MHz band are protected from harmful interference. Unfortunately, the material jointly presented to

Commission staff by LightSquared and Javad (at least as reported in the LightSquared Letter) raises more questions than it answers. Until testing is able to confirm the claims in these filings, until it is confirmed that the new filtering will not impose any performance penalty on GPS and RNSS receivers, and until LightSquared makes the essential commitments to remove the upper 10 MHz from future consideration and to pay all of the costs associated with retrofitting existing GPS receivers that would receive harmful interference from a lower 10 MHz 4G LTE terrestrial mobile service, the so-called Javad “process” must be regarded as just another unproven potential mitigation technique. LightSquared needs to make a stable and comprehensive operational proposal to the Commission and demonstrate that the Javad process or some other new filtering/reconfiguration process is able to meet all of these conditions.

The Latest “New” Ceramic Filter

LightSquared’s claims regarding insertion loss of a supposed new ceramic filter from a company called Partron are insufficiently fleshed out in Attachment C to the LightSquared Letter, and appear to be inaccurate. Although details are in short supply, the USGIC has serious questions about the accuracy of the claims LightSquared advances regarding insertion loss. For example, LightSquared claims that the new filter has “an insertion loss of about 1.7 dB maximum in the L1 passband” (*see* LightSquared Letter at 2), yet the data provided in Attachment C of the same document clearly shows that the specification over the passband is 3.0 dB – and even then only at a single temperature. To put this into perspective, the filter insertion loss at the front end of the receiver is only one component of the receiver’s noise figure, which GPS designers go to great length to minimize. A 3 dB insertion loss is noticeably greater than the entire noise figure of most precision receivers sold today.

As it has for the previous filter “solutions” LightSquared has proposed – filters with spec sheets, but that did not materialize for testing and are no longer mentioned by LightSquared – the USGIC must again emphasize that any determination regarding the suitability of the forthcoming Partron device as a mitigation technique is premature. No filter is available today for essential testing, and until prototype devices are tested, any mitigation prospect the filter offers is merely hypothetical.

Additionally, and as discussed above, it is unclear whether the proposed new filter from Partron would impose any kind of unacceptable performance penalty on GPS receivers, and there is serious question as to whether the identified filter or filters would be appropriate for and installable in the many different types of GPS receivers in use today that are subject to harmful interference from LightSquared’s proposed 4G LTE terrestrial mobile service in the lower 10 MHz of the 1525-1559 MHz band.

Limiting Power on the Ground

At the end of the LightSquared Letter, LightSquared notes that it provided a presentation that focused on “the topic of limiting power on the ground in the vicinity of LightSquared base stations” LightSquared Letter at 2 and Attachment D. LightSquared’s “power on the ground” proposal has two components – Option 1 and Option 2. There are multiple problems

with both options, and the USGIC has serious concerns whether the outlined techniques present a viable means of mitigating the interference potential to GPS receivers in the vicinity of LightSquared 4G LTE base stations as currently formulated.

Option 1 has been addressed in detail in an October 28, 2011 *ex parte* presentation by Garmin International, Inc. (“Garmin”) in the above-referenced proceedings. *See* Letter from M. Anne Swanson, Counsel for Garmin, to Marlene H. Dortch, Secretary, FCC in IB Docket No. 11-109 and File No. SAT-MOD-20101118-00239, at Attachment (“Garmin Response to LightSquared’s September 27, 2011 Ex Parte Filing Regarding Its ‘Power On the Ground’ Proposal”) (filed October 28, 2011). The USGIC fully endorses the Garmin position on “Option 1.”

The deficiencies in LightSquared’s proposed Option 2 are discussed in the technical analysis appended as Attachment A to this letter. As Attachment A explains in detail, Option 2, which would set EIRP limits for LightSquared base stations depending on the base station antenna height, would also produce power levels that create harmful interference when appropriate propagation models are utilized. In addition, the antenna proposed in Option 2, as well as another antenna model LightSquared previously said should be utilized in all TWG analyses, in fact provide maximum power on the ground in excess of the -30 dBm level that LightSquared proposes for its first several years of operations. Finally, as discussed in Attachment A, LightSquared’s analysis in Option 2 fails to take into account that when terrain elevation and raised structures such as elevated highways are considered, the interference power on the ground can increase by as much as three times.

Given these issues, LightSquared’s presentation on reduced power levels raises significant concerns that need to be fully addressed. To date, LightSquared has failed to provide the technical data necessary for such study and analysis. What is required is a detailed, comprehensive technical study and analysis that considers the LightSquared antenna pattern, beam downtilt, the impact of multiple transmitters, and various propagation models (including full use of free-space propagation).

* * *

GPS and other RNSS services are thoroughly integrated into all aspects of our society and economy. The Commission needs to ensure their continued protection from harmful interference.

As the entity that is proposing a fundamentally new use of satellite spectrum, and one which is not consistent with Commission and ITU tables of frequency allocations, it remains exclusively incumbent upon LightSquared to demonstrate that its operations will not cause harmful interference to any authorized users of allocated spectrum. This exclusive responsibility includes reimbursing up front and in full any and all costs GPS and other RNSS users would need to incur to make existing and deployed receivers immune from such interference.

Ms. Marlene H. Dortch

November 9, 2011

Page 7

If there is to be any prospect of favorable action on a future LightSquared proposal to mitigate interference to RNSS receivers, three things must happen. First, LightSquared must make a comprehensive operational proposal to the Commission that addresses all RNSS receivers. Right now, all that exists are incomplete *ex parte* submissions addressing particular issues in piecemeal fashion. Second, all possibility of 4G LTE operation occurring above 1536 MHz must be unequivocally disavowed by LightSquared and permanently forbidden by the Commission. There is no evidence that 4G LTE terrestrial mobile operation in the 1545-1555 MHz band is now, or can ever be, compatible with GPS and other RNSS operations in the upper adjacent 1559-1610 MHz band. Third, LightSquared must stop attempting to escape its obligation to pay for any changes to existing GPS devices and applications that could potentially make meaningful terrestrial-only use of a portion of its MSS/ATC spectrum possible, and accept full responsibility for ensuring that all existing GPS operations are able to operate as they now do without experiencing harmful interference from LightSquared. Unless all three of these prerequisites are satisfied, the Commission must continue to preclude LightSquared from offering any 4G LTE service in its licensed MSS/ATC bands.

Please contact me if you have any questions regarding the foregoing points or the material in Attachment A.

Respectfully submitted,

A handwritten signature in blue ink, appearing to read 'F. Michael Swiek', with a long horizontal stroke extending to the left.

F. Michael Swiek
Executive Director
U.S. GPS Industry Council
mswiek@mike-intl.com

cc: Brian Butler
John Gabrysch
Clifford Gonsalves
Brett Greenwalt
Michael Ha
John Kennedy
Julius Knapp
Jeremy Marcus
Paul Murray
Sankar Persaud
Ronald Repasi
Mark Settle
Darryl Smith

ATTACHMENT A

Executive Summary

In attachment D of its October 6, 2011 ex parte report, LightSquared introduced a “power on the ground” proposal with a variation that it identified as “Option 2.” Rather than measuring interference power on the ground and restricting it to specified levels, Option 2 would set limits on the maximum EIRP that could be transmitted from a base station depending on the base station antenna height. LightSquared’s specific parameters for this proposal are set forth in Figure 1.

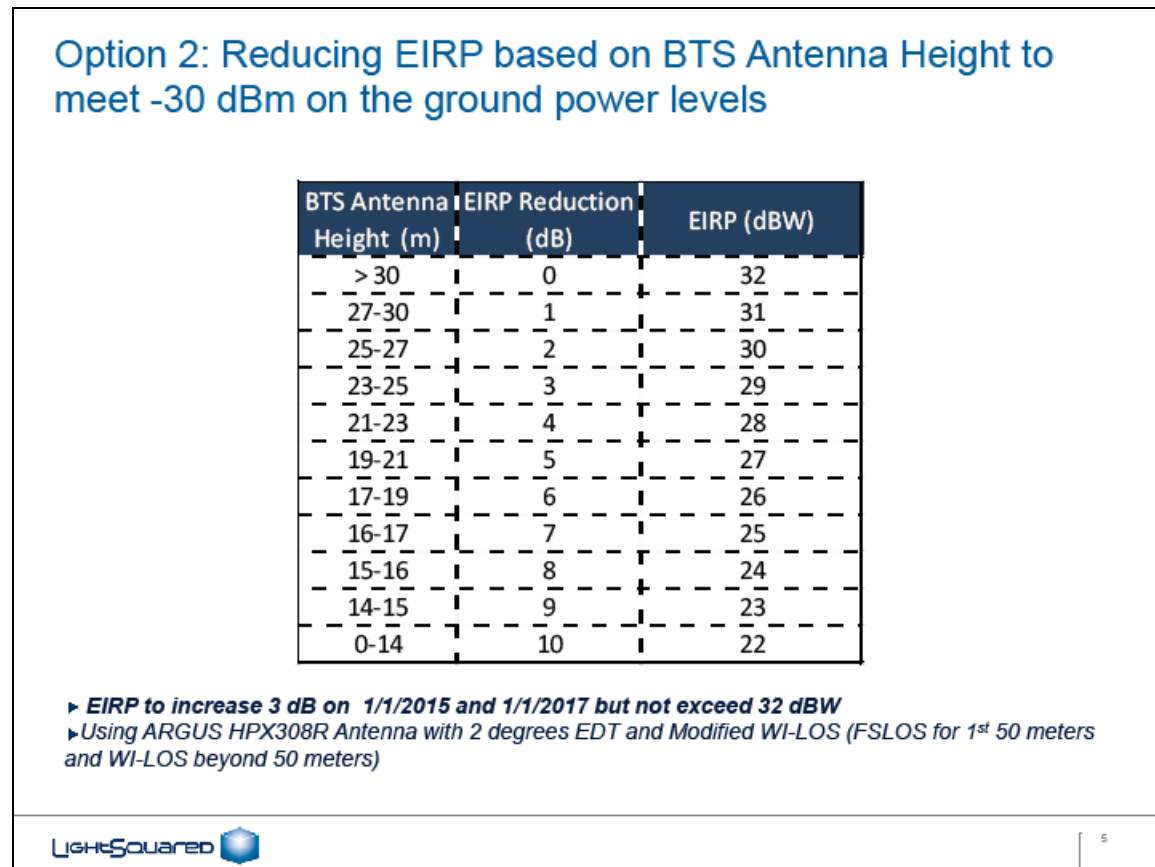


Figure 1. LightSquared’s “Option 2” Proposal of Maximum EIRP as a Function of Base Station Antenna Height.

LightSquared’s Option 2 proposal is a completely unsuitable solution. Significant problems with this proposal include:

- The power on the ground that results from LightSquared’s proposed transmit powers still creates harmful interference when the proposal is analyzed using an appropriate propagation model suitable for interference analysis.
- The LightSquared interference power on the ground is significantly affected by the transmit antenna pattern. LightSquared seems to vacillate between two different transmitter antennas, each with its own unique pattern. Using either antenna, however, LightSquared’s operations will provide a maximum power on the ground in excess of -30 dBm, the level to which

LightSquared has said it will restrict its operations during the first several years of its new service.

- LightSquared's analysis is overly simplistic and unrealistically assumes that the earth is completely flat around the transmit tower. When terrain elevation and raised structures such as elevated highways and overpasses are taken into account, the interference power on the ground can more than triple.
- LightSquared's analysis assumes that the base station transmit antennas will never exceed 2 degrees of antenna beam downtilt. Merely adjusting the transmit antenna downtilt by an additional four degrees will cause the interference power on the ground to almost triple. The design of terrestrial wireless networks frequently involves much greater downtilt, particularly in urban areas.

The problems with the original "power on the ground" proposal, or Option 1 in the October 6, 2011 LightSquared ex parte, are discussed in Garmin's September 15, 2011 and October 28, 2011 ex parte reports, and these are incorporated herein. As described below, the new proposal (Option 2) to limit power based on the base station antenna height has additional shortcomings.

The Proposed LightSquared Transmit Powers Still Create Harmful Interference

Option 2 brings back an inappropriate path loss model that LightSquared has previously used to argue that there would be no impact to cellular and general location and navigation devices from operations of its proposed service. The choice of propagation models used to analyze the impact of LightSquared interference has been an ongoing source of debate between the GPS community and LightSquared. The GPS community maintains that path loss models such as LightSquared's preferred Walfisch Ikegami are only intended to model the average power levels a user would expect to see on the ground and are therefore not appropriate for use in an interference analysis because they do not account for the variations in path loss that may be observed at a given site. For long distances, the Irregular Terrain Model (ITM) would be a good choice, but the analysis contained here is at or below 600 meter distances, less than the minimum 1 km range for which ITM is valid. Thus a free space propagation model is a reasonable alternative for short distances and also has the benefit of being deterministic and providing a lower bound on the path loss that would be seen at a given distance from the transmitter.

When a free space model is used, much larger reductions in the power transmitted by the LightSquared base stations are required to ensure that the power on the ground will not exceed the -30 dBm limit that LSQ has proposed. The following graph depicts the expected power on the ground that would be seen at various distances from the base of a LightSquared tower using the free space model.¹

¹ The plot is based on the same ARGUS HPX308R antenna that was referenced in the LightSquared October 6, 2011 ex parte filing. The antenna gain pattern data for the ARGUS HPX308R antenna can be obtained from the FCC's website at (<https://apps.fcc.gov/els/GetAtt.html?id=114834&x>)

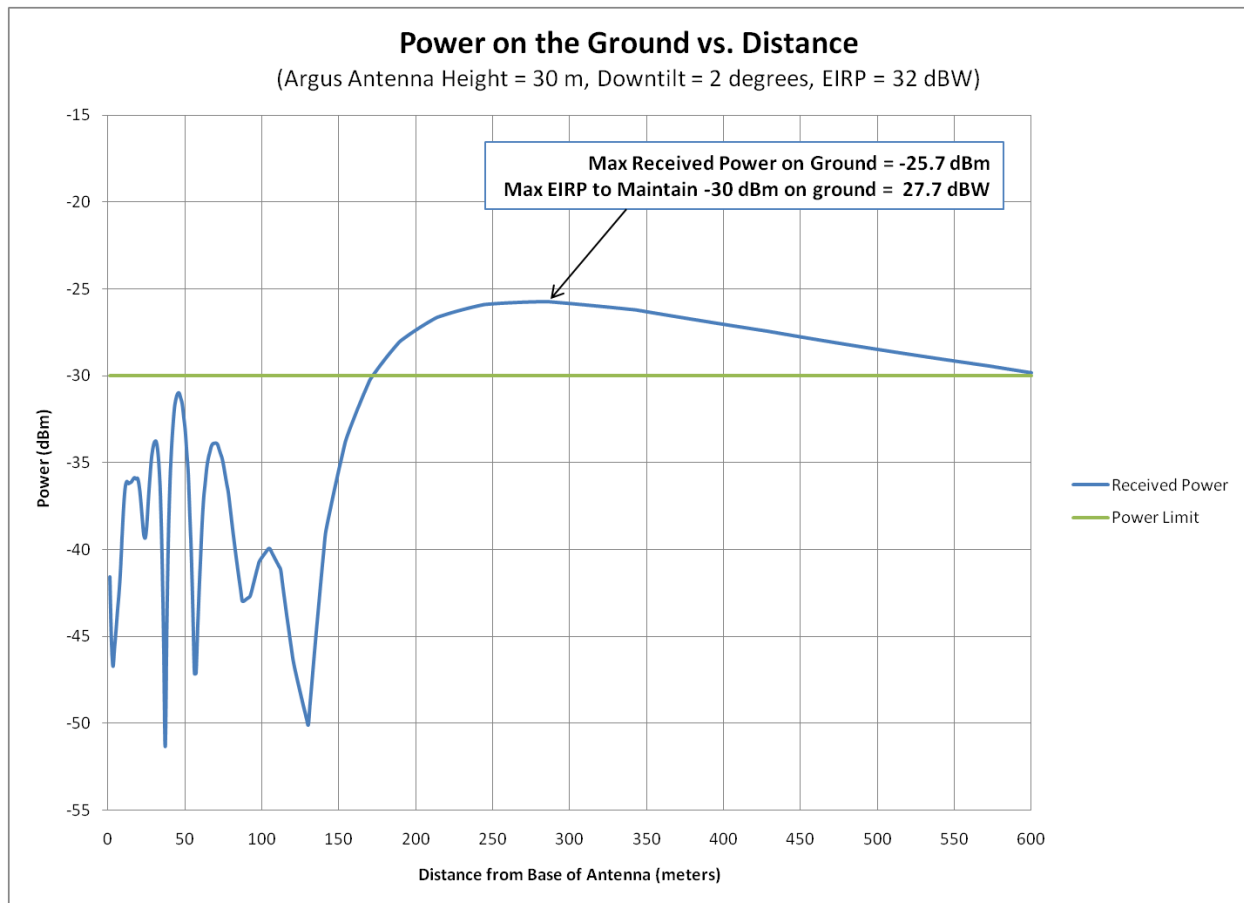


Figure 2. LightSquared Interference Power on the Ground vs Distance Using a Free Space Propagation Model, Argus HPX308R Antenna, 32 dBm EIRP.

As can be seen, the power on the ground exceeds LightSquared's proposed -30 dBm limit by up to 4.3 dB at distances from 175m to 600m from the base station. In order to actually provide LightSquared's -30 dBm power limit, the base station EIRP must be reduced by 4.3 dB to 27.7 dBW from LightSquared's proposed 32 dBW.

Because the Interference Power Is Greatly Affected by the Transmit Antenna Pattern, Any Proposal to Limit Transmit Power Based on Antenna Height Must Specify the Transmit Antenna.

Analysis of received power on the ground is very dependent on an antenna's vertical gain pattern because as a receiver moves close to the foot of the base station antenna, it moves out of the main beam of the antenna. Two different base station antennas have been proposed by LightSquared – the Argus HPX308R that is assumed above, and the Tongyu TDJ-151717DE antenna that was assumed in the analysis performed by many sub-teams in the Technical Working Group. The vertical gain patterns for the two antennas are quite different underneath the main beam. The elevation plots for the two antennas provided below illustrate this.

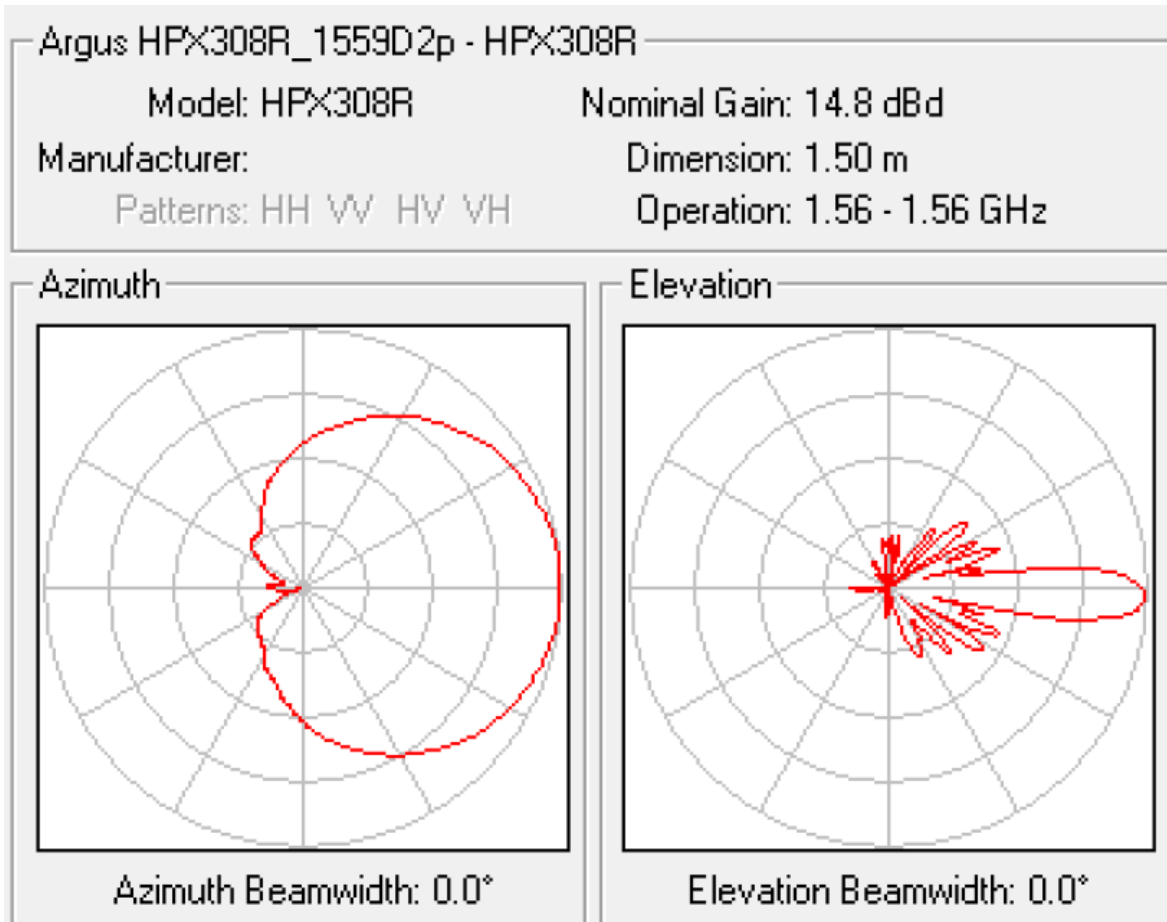


Figure 3. Antenna Gain Pattern of Argus HPX308 Transmit Antenna

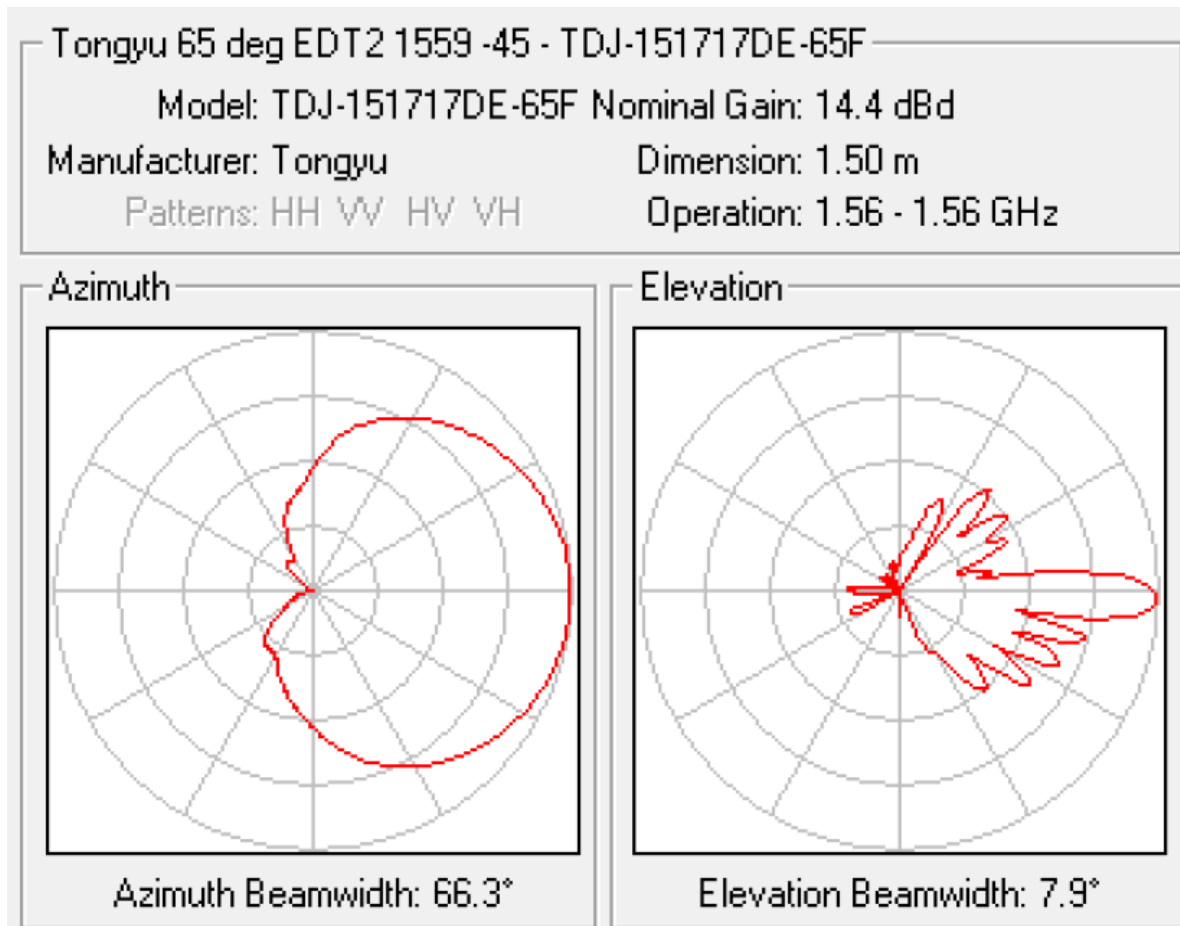


Figure 4. Antenna Gain Pattern of Tongyu TDJ-151717DE Transmit Antenna

The Tongyu antenna radiates noticeably more power below the main antenna lobe than the Argus antenna.² This means that if a Tongyu antenna were used in a base station installation, far greater interference power would be experienced on the ground near the tower than if an Argus antenna were used. It is far from clear whether LightSquared has ruled out the use of the Tongyu antenna, as it was extensively used in the Technical Working Group analysis.³ LightSquared also specified the use of the Tongyu antenna in RTCA SC-159 analysis.⁴

²As was the case for the Argus HPX308R antenna, the Tongyu antenna plot depicted here was obtained from the FCC's website at (<https://apps.fcc.gov/els/GetAtt.html?id=114753&x>)

³ For example, the Space Based sub-team of the TWG used the Tongyu antenna pattern in all of its analysis. See TWG Report at page 302. The Cellular sub-team uses the Tongyu antenna in its analysis as well. See TWG Report at page 101. Also, the High Precision sub-team extensively uses the Tongyu antenna in its analysis of the Las Vegas Live Sky results. For example, see Appendix H.1.2 pages 4 and 5 where the properties of the Tongyu antenna are discussed in reference to the Live Sky data analysis.

⁴ An email from Santanu Dutta, April 5, 2011 provided the Tongyu antenna pattern. Text of the email below (emphasis supplied):

Hello RTCA WG-6,

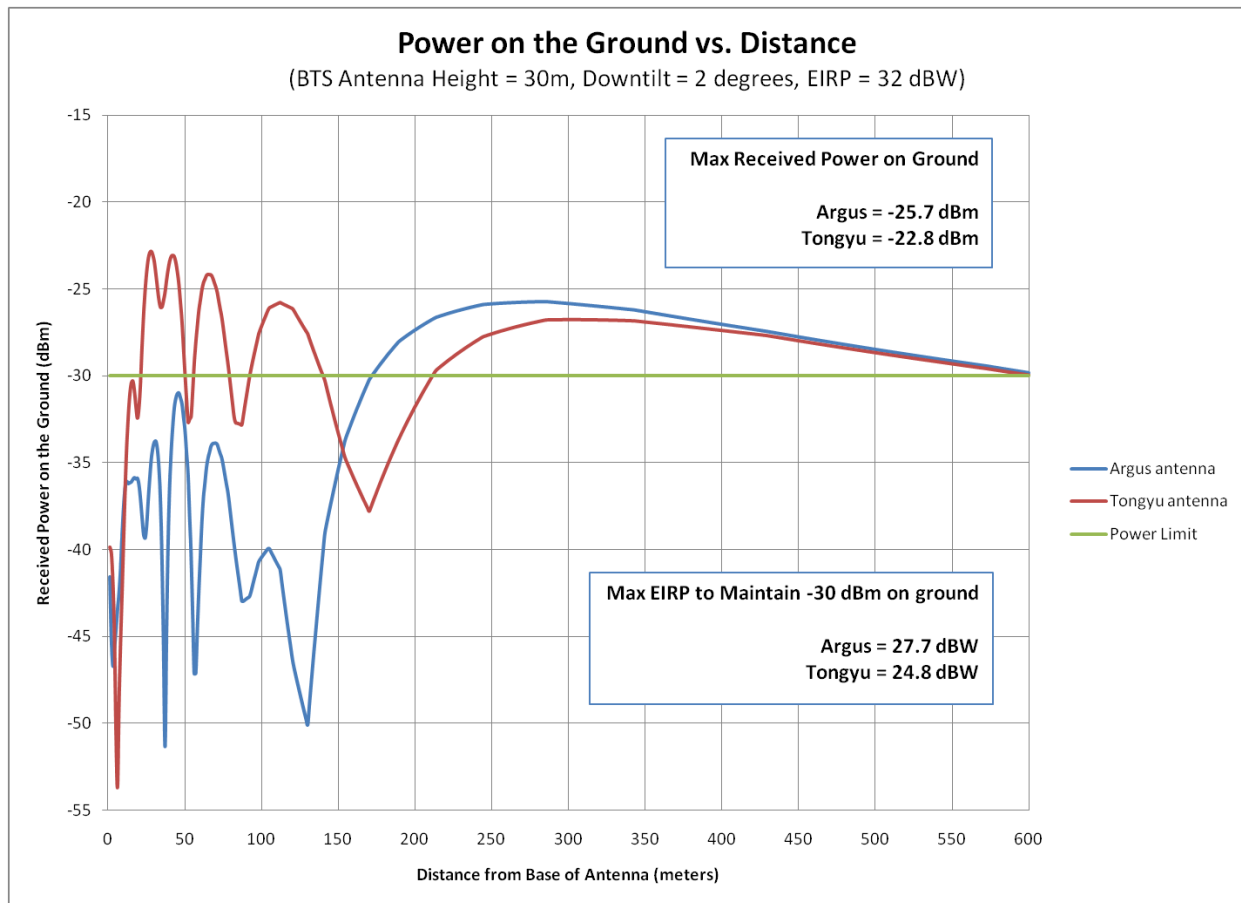


Figure 5. Power on the Ground vs. Distance for Tongyu (Red) and Argus (Blue) Transmit Antennas

Figure 5 illustrates this fact. Note that the maximum power on the ground when using a Tongyu antenna is -22.8 dBm, more than 7 dB above LightSquared's -30 dBm limit. With the Tongyu antenna, the maximum power on the ground occurs close to the base of the tower, even though the receiver would be out of the main beam of the antenna. Further, the peak power on the ground from the Tongyu

Attached is the LightSquared base station antenna pattern that should be used for all analysis of all potential interference scenarios involving LightSquared base stations. Some of you have already received this data in the past. The purpose of this dissemination is to ensure that a common database is available to all. Please note that this pattern is formatted with 0° downtilt. 2° downtilt is the deployment plan of record and should be assumed in all analyses.

This fulfills an action I had taken in a recent TWG Aviation Subgroup meeting.

Santanu Dutta

antenna is almost 3 dB higher than what would be seen with the Argus antenna. There are two important points illustrated by this plot:

1. The Argus and the Tongyu antennas, two antennas proposed by LightSquared as being used in their terrestrial deployment, will in fact provide power in excess of -30 dBm on the ground.
2. The choice of transmit antenna (and the transmit antenna gain) is a critical parameter for determining the power on the ground. LightSquared's proposal to reduce EIRP based on antenna height is not credible unless it accounts for the different gain patterns of the antennas that will be deployed as part of LightSquared's network.

A "Flat Earth Model" Is Unrealistic and Underestimates the Interference Threat

The new proposal to reduce ATC EIRP based on antenna height also unrealistically assumes that the affected receivers will always be at the same elevation as the base of the antenna tower. This assumption ignores the possibility of rising terrain around the base station or the use of GPS on elevated structures such as elevated highways near a base station and understates the interference power that can be expected in these very common situations. Increases in the height of the receiver relative to the base station antenna put the receiver closer to the main beam of the antenna. The height of the base station antenna relative to the receiver must also be taken into account when determining the power on the ground.

Consider a case such as the one depicted below in which a car is on an elevated highway near a cell tower.



Figure 6. Cell Tower Base Station Near an Elevated Freeway



Figure 7. Close Up View of Cell Tower

Assume as an example that the receiver is 200 meters from a LightSquared base station on an elevated freeway approximately 15 meters (50 feet) above the ground. The LightSquared base station has an antenna height of 30 meters. In this case, the base station antenna is only 15 meters above the receiver. As the chart below indicates, the receiver would see a power level of -21 dBm at a distance of 200 meters from the base station.

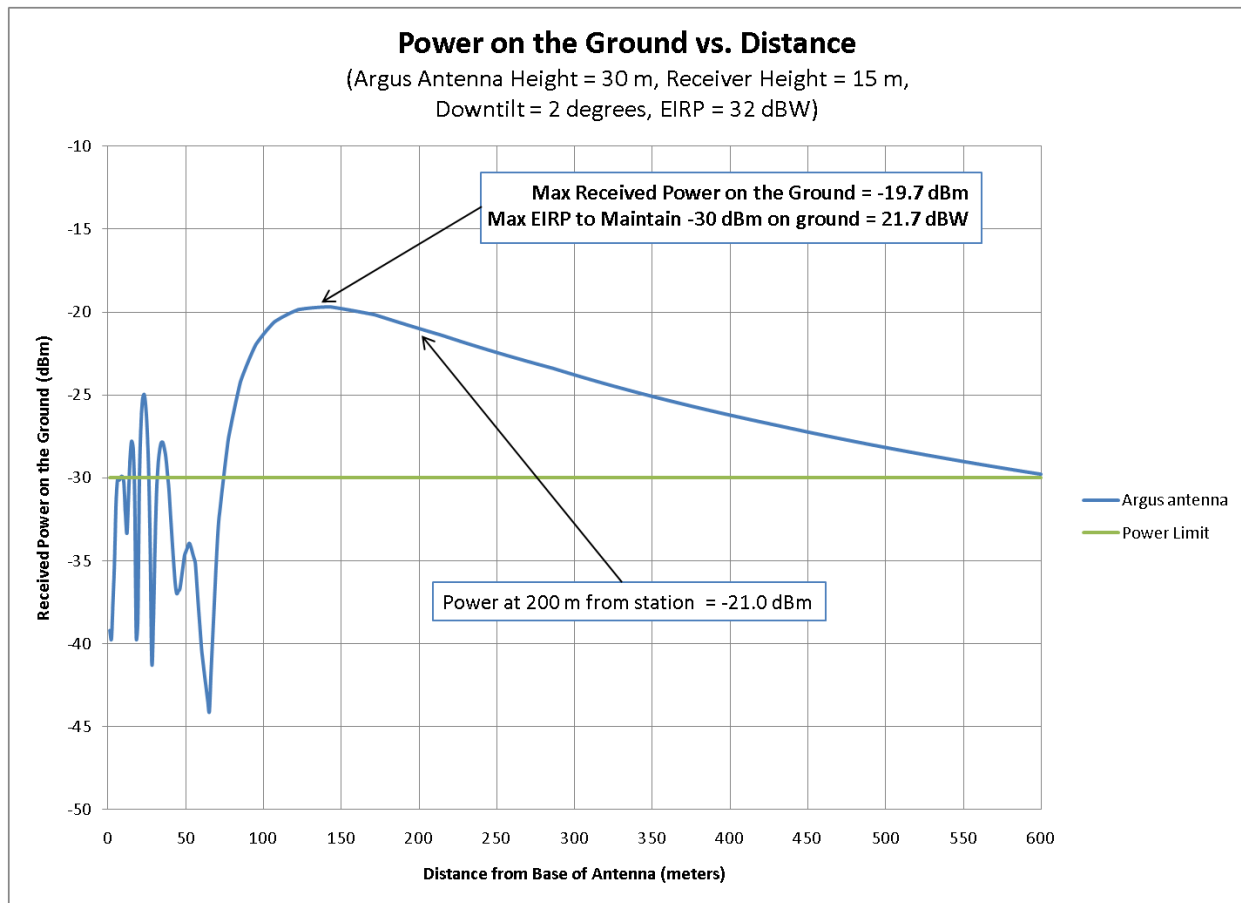


Figure 8. Effect of Receiver Height on Received Power, Transmit Antenna 30 m, Receiver Antenna 15 m.

This chart shows a power level 9 dB, or eight times greater than the -30 dBm level proposed by LightSquared. It clearly demonstrates that variation in receiver height must be properly accounted for in an interference mitigation proposal, which is not the case in LightSquared's proposal.

Physical Antenna Downtilt Will Increase Interference Power on the Ground Drastically

In addition to questionable assumptions about receiver height relative to the base station, the LightSquared proposal also assumes that the base station antennas will be downtilted by two degrees. As indicated by ClearWire in their July 15th comments on the Technical Working Group report, two degrees of downtilt is not realistic and there will be many instances where the design of the cellular network dictates that the base station antenna be downtilted by much more than two degrees.⁵ If the

⁵ See for example I. Forkel, et. al., "The Effect of Electrical and Mechanical Antenna Down-Tilting in UMTS Networks," *Proceedings of the International Conference on Microwaves, Radar and Wireless Communications*, 2002. Also see F. Gunnarsson, et. al., "Downtilted Base Station Antennas – A Simulation Model Proposal and Impact on HSPA and LTE Performance." *The 68th IEEE Vehicular Technology Conference*, Sept. 2008.

base station power is fixed, decreasing downtilt will increase the power on the ground. The following chart illustrates this effect:

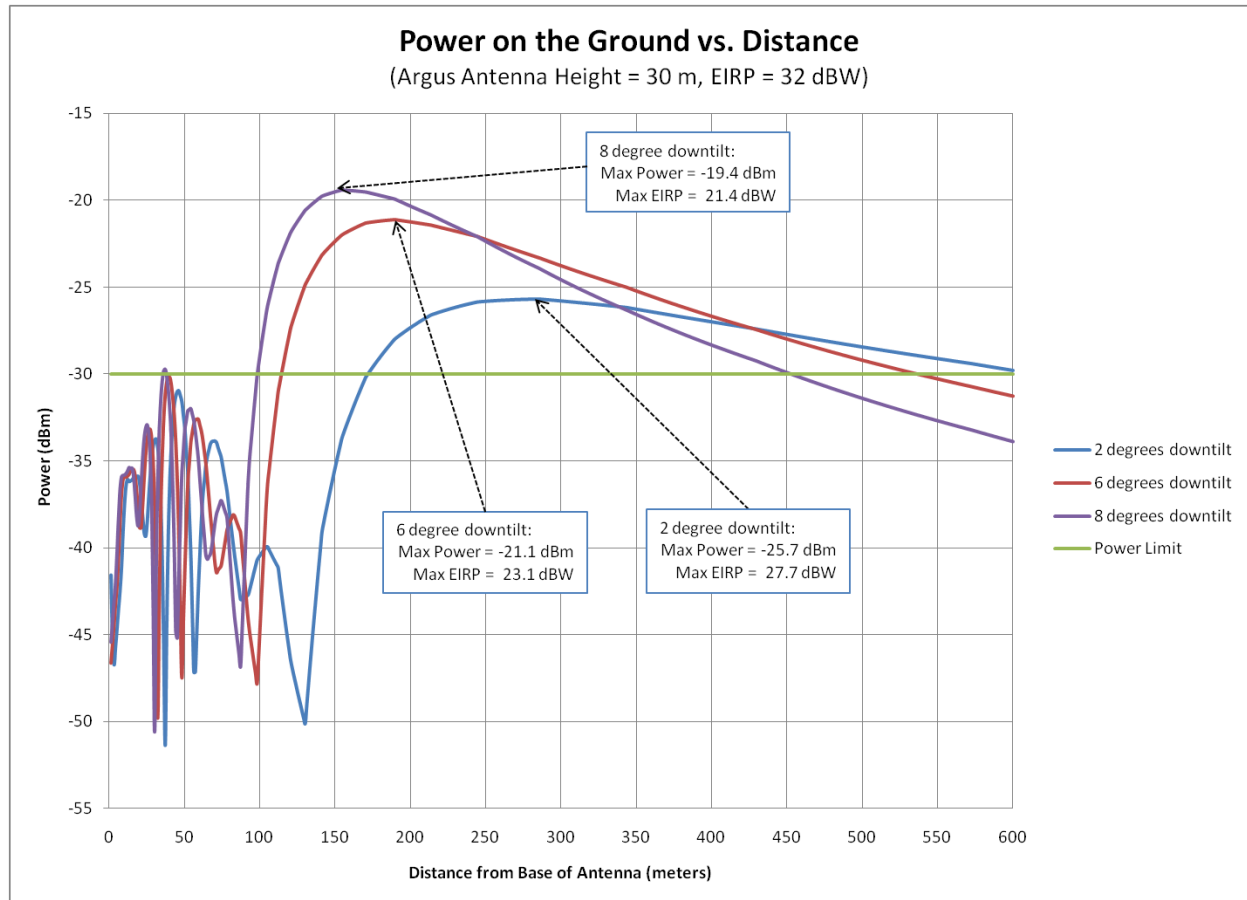


Figure 9. Power on the Ground as a Function of Antenna Downtilt, Argus Antenna

As can be seen from the plot above, merely increasing the antenna downtilt by four degrees raises the maximum power observed on the ground to -21.1 dBm, which is almost 9 dB (almost 8 times) higher than the -30 dBm limit proposed by LightSquared. It is also 4.6 dB higher than the power levels expected with a two degree downtilt – almost tripling the peak power on the ground. Downtilting the base station antenna by 8 degrees increases the maximum power on the ground to -19.4 dBm.